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In re application : Jonathan H. Monin, et al.
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For : FLEXIBLE WIRELESS LOCAL NETWORKS
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By
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Registration No. 25,467
Attorney for Applicant(s)

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PRIORITY CLAIM UNDER RULE 55

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Sir:

The benefit of the filing date in the United States of a provisional patent application corresponding to the above-identified application is hereby claimed under Rule 55 and 35 U.S.C. 119 in accordance with the Paris Convention for the Protection of Industrial Property. This benefit is claimed based upon a corresponding United States provisional patent application bearing serial no. 60/300,269 filed June 22, 2001; a certified copy of which is attached hereto.

Respectfully submitted,

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November 02, 2001

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APPLICATION NUMBER: *60/300,269*
FILING DATE: *June 22, 2001*

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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TITLE OF THE INVENTION (280 characters max)

A FLEXIBLE CELLULAR SYSTEM

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

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ENCLOSED APPLICATION PARTS (*check all that apply*)

[X] Specification with drawings — *Number of Pages* 25
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[ ] Applicant claims small entity status. See 37 CFR 1.27.
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[X] No.
[ ] Yes, the name of the U.S. Government agency and the Government contract number are: ______

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Date: June 22, 2001
REGISTRATION NO. *(if appropriate)*: 24,156
Docket Number: 205,223

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

PROVISIONAL APPLICATION COVER SHEET
Additional Page

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Docket Number	205,223	Type a plus sign (+) inside this box →	+

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A flexible cellular system

1. Background of the invention

1.1 Cellular communication system

Cellular communication is a technology for providing wireless communication services to mobile terminals. Cellular communication is an established and well-known technology worldwide. Typical implementations, which employ cellular communications, include GSM networks, wireless LAN (IEEE 802.11), HyperLAN, the Bluetooth™ standard and others.

1.2 Cellular communication system components

A Cellular system is typically built of many components. This document will focus on the mobile terminal, the access point, the central station, one or more and the transport network. The transport network connects the access points to the central stations. These are the components of interest for the invention. The components are presented, schematically, in figure 1.

The infrastructure segment of the cellular communication system includes all components of the system except for the mobile terminal component.

Each central station may interface other components of the cellular system which are not discussed in this invention.

1.2.1 Mobile terminals

Mobile terminals may be Cellular Phones (as in the case of GSM networks). Mobile terminals may also be notebooks equipped with a special PC-Card (as in the case of Wireless LAN IEEE 802.11) or Personal Digital Assistance (PDAs) devices equipped with a special chip set (as in the case of Bluetooth™ technology). Mobile terminals may also come in other forms and shapes. Mobile terminals may support voice services, data services or both. Mobile terminals may be based on powerful hardware components (e.g. high-speed processors, large SVGA color display) or may come as "thin clients" with minimum processing and hardware capabilities.

The plurality of different mobile terminals and the existence of "thin clients" implies, that a high performance cellular system should rely, as minimum as possible, on the cooperation of the mobile terminal component.

1.2.2. Access points or radio stations

Access points or radio stations are those elemen <u>directly</u>, in a wireless fashion, to mobile termina mainly in connection with technologies of confi

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radio station is mainly used in connection with large outdoor systems. From here on, the term access point shall be used in this document but will represent both cases.

The functionality and structure of access points may differ from system to system.

Access points may be sophisticated and perform as IP routers between the mobile terminals and the Global Internet. Access points may provide minimal functionality and merely re-direct voice or data to servers, switches or control stations. Access points of certain technologies may support multiple simultaneous links to many mobile terminals over very large areas (say a hundred of mobile terminals covering an area of 10 km^2). Access points of some other technologies may support a single mobile terminal within a radius of 10 m.

Access points may be structured as a single pack, which includes the antenna, the receiver, transmitter and all the required functionality (logic) of an access point. Access points may also be configured in separate physical devices. For example, the processing and logic of the access point may reside in one enclosure (sometimes called base station) and the antenna may be set in a different location. The former type of access point is of the integrated type. The latter one is of the split type. Both are schematically shown in figure 2.

In all cases, access points are entities with some kind of an identity; e.g. an address or frequency-hopping pattern. The identity of the access point allows a mobile terminal to link itself with a specific access point. The sub-system within the cellular system, which handles the identity and the link to the mobile terminal, will be referred to, in this document, as the identity module.

1.2.3 Central station

In a typical cellular communication system, access points are connected to each other or to other parts of the system through an intermediate entity. This entity may be a server, a switch or a dedicated control station, all of which will be collectively referred to as the central station in this document. Central stations may connect to some or all access points. The functionality of central stations vary and may include authentication of mobile terminals, handover control (see a following section), connection to a wired infrastructure and more.

1.3 Challenges in cellular communication systems

Cellular communication systems need to handle multiplicity of challenges ranging from security issues, transmission power control, high quality voice and others. This document will focus on two challenges related to the mobility of mobile terminals: the handover and temporary clustering.

1.3.1 Handover

Mobile terminals may move about the coverage area of the cellular communication system. While moving around, a mobile terminal may get drawn away from one

access point and may approach another access point. If the mobile terminal is linked to and communicating through the first of the two access points, than the system needs to transfer the link to the other access point. This would allow the mobile terminal to continue the communications even when the wireless link to the first access points weakens and eventually disengages. A typical configuration, where one mobile station is linked to one access point and is moving towards a second access point is described in figure 3.

The mobile terminal, access point or central station may initiate the handover process. The mobile terminal, access point or central station may control the handover process. Either way, handover is a very sophisticated process that consumes a lot of system resources. When conditions are not preferable, the user of the mobile terminal may experience the handover process as noticeable disturbances. In other cases, the handover process may fail altogether and inadvertently disconnect the mobile terminal from the system.

For the purposes of this invention, it is important to distinguish between link handover and mobile IP procedures. Link handover deals with the primary and direct connection made between a mobile terminal and an access point. Mobile IP procedures deal with non-interruptible end-to-end connection. The end points usually involve a mobile terminal and some server, either a local server or a remote server located somewhere within the Global Internet. The access point itself is very rarely an end point for connection. Furthermore, mobile IP procedures relate to IP data services whereas link handover is required for all services, whether voice, non-IP data or IP data.

This invention describes a method for an innovative link handover. Once link handover is dealt with, mobile IP procedures may also be exercised if so required.

1.3.2 Temporary clustering

Mobile terminals may move about the coverage area of the cellular communication system. Statistically, clustering of many mobile terminals within the coverage area of one access point may cause the access point to become congested and disallow new connections to (or handover from) mobile terminals. The typical solution involves the construction of redundant bandwidth resources (e.g. more access points) in areas prone to clustering.

1.4 Uniqueness of small cells deployment

Theoretical research in the area of cellular communication systems indicates that cellular systems benefit from the employment of small sized cells. For example, small sized cells provide higher bandwidth per mobile terminal, are flexible for installation, may be optimized for location based services, allow low transmission power and more. It is therefore expected that cellular systems, based on small sized cells, will be deployed in growing numbers. Alas, these systems do suffer from several acute drawbacks, which are either resolved or completely bypassed by the current invention.

The invention presented in this document is relevant to all types and configurations of cellular communication systems. Nevertheless, some of the unique advantages of the invention are more evident in cellular systems characterized by small cells, each cell supporting a modest number of mobile terminals. This section will elaborate on some of the pertinent features of small cell systems.

A small cell is sometimes designated as a pico-cell or micro-cell and refers to cells with radius of coverage ranging from about 10 meters to several hundred meters. The cell may support between one to several tens of mobile terminals.

1.4.1 Handover

Handover is clearly more apparent in small cells than in larger ones. Assume a cell of 10 m radius. A user, equipped with a mobile terminal, walking at a standard pace, would need to exchange access points every 5-20 seconds. In contrast, the same user, riding a 60 km/h car would need to exchange access points every 5 minutes assuming cell coverage of 2-3 km radius. In the first case, a typical voice conversation would exhibit 10-15 handover acts, compared with one or no handover for the second case.

1.4.2 Temporary clustering

Temporary clustering is also more apparent in small cells. Assume a cell supporting four mobile terminals within a 10 meters radius. Statistically, we would like to support $4 \pm \sqrt{4}$ mobile terminals – resulting in a 50% redundancy requirement. In contrast, a large cell supporting 100 mobile terminals should probably support $100 \pm \sqrt{100}$ mobile terminals with mere 10% redundancy.

Brief summary of the invention

The object of this invention is to provide new flexibility features to cellular communication systems, in particular those systems based on small sized cells.

Cellular systems are realized by different technologies; GSM, IEEE 802.11 and the Bluetooth standard to name a few. Cellular system architectures are characterized by an access point entity (also called base station or aerial) and another entity serving as a central station. The central station controls several access points. The invention may be implemented in all types of cellular systems, which follow this architectural structure. The invention may also be implemented in a combined system where different technologies coexist.

The new flexibility features provide improved performance in some of the technical challenges typical of cellular communication systems. In particular, the invention handles the control of the handover process (serving mobile users on the move), support for temporary and locally uneven user traffic and dynamic distribution of system resources.

The invention does not rely on any particular features of mobile units. On the contrary, all types of mobile units will enjoy the new capabilities. As a result, diverse mobile terminals such as Cellular phones, PDAs and notebooks will all enjoy the new features of the system.

The underlying technique for adding flexibility to the system is based on changing the classical functionality of several cellular system components. More specifically, the invention is based on detaching the fixed affiliation, between access points or base station and their identity. By detaching this fixed affiliation, the access points may now be assigned and reassigned anew identity on a dynamic basis. The algorithm for assigning the identities to access points may vary, but is, in general, dependent upon the user movement around the site.

2. Detailed description of the invention

2.1 Overview of the invention essentials

This invention is based on a fundamental change in the functionality of an access point.

Specifically, the identity module (section 1.2.2) is detached, logically, from a permanent attachment to the access point. Furthermore, the identity modules of the cellular system are assigned and reassigned, on a temporary basis to different access points within the system. The reassignment is made in accordance with a pre-defined algorithm, which may be optimized, for differing requirements. Figure 4 illustrates the separation of identity modules from access points, an initial assignment and a possible reassignment. As presented in figure 4, some cellular system configurations allow assignment of more than one identity module to the same access point; others will allow assignment of an identity module to more than one access point. Furthermore, some access points and identity modules may be inactive.

Once this is done, the cellular system gains tremendous flexibility in a variety of operations including handover procedures, dynamic resource allocation, support of "thin" mobile terminals, designating access points to identity modules from different technologies and more. For example, the algorithm dictating the assignments and reassignments of one specific identity module may be designed for tracking a mobile terminal as it roams about the cellular system coverage area.

2.2. Implementation methods

Three implementation methods need to be described. First, a method for detaching the identity module from the access points will be described. Second, several methods for continuously re-assigning identity modules to different access points will be presented. Third, an algorithm for controlling the re-assignment process will be described.

Due to the diversity of cellular communication systems, it is not possible to cover implementation details for all system types. In what follows, a detailed implementation description will be provided for one typical cellular system – based on Bluetooth™ technology. Implementation details will vary between different systems but are all based on the same innovative concepts introduced in this invention.

2.2.1 Brief description of a cellular Bluetooth™ system

In a typical Bluetooth™ system the mobile terminals are any kind of devices which include a Bluetooth™ radio module. The access points usually conform to the LAN Access Profile (LAP) or Network Access Profile (NAP) as defined in the Bluetooth™ Specifications. The access points usually take the from of suspended units (on the

ceiling /walls of a site). When so implemented, the central station may take the form of a Bluetooth™ server, which manages the access points, takes care of mobile IP procedures (e.g. IP roaming), handles authentication and more.

2.2.1.1 Access point assembly

A typical Bluetooth™ access point may be assembled from:

(a) An antenna operating at 2.4-2.48 GHz
(b) A radio module implemented as a VLSI chip
(c) A Baseband module implemented as a VLSI chip
(d) A processor plus memory module executing the higher layers of the Bluetooth™ protocol stack
(e) An Ethernet controller and driver for bridging between the Bluetooth™ link and a wired Ethernet based network.

This assembly is a typical one. The assembly is provided in this document for the sake of clarity and to allow an in-depth description of a typical implementation of the invention. The invention may also be realized in systems, employing other types of access points. For example, the invention may be realized in systems where the access points implement the radio module and Baseband module in one VLSI chip. As another example, the invention may be realized in systems where the functionality of the access point is split between a suspended unit and a central station with a Transport HCI interface (as defined in the Bluetooth™ specification) in between the two elements.

2.2.1.2 Bluetooth™ system procedures

The typical procedures describing Bluetooth™ system operations are:

(a) Either the access point or the mobile terminal search for neighboring Bluetooth™ devices. This stage is termed "inquiry" in the Bluetooth™ specifications.

(b) The mobile terminal is linked to a neighboring access point. The mobile terminal, the access point or the user of the mobile terminal may initiate this phase. This stage is termed "paging" in the Bluetooth™ specifications.

(c) An authentication process may follow. The process may involve databases external to the access point.

(d) Once a link has been established, the linked devices form a network, termed piconet in the Bluetooth™ specifications. More mobile terminals can join this piconet to a total of seven devices linked to one access point. In the final configuration of a piconet, the access point plays the special role of a "master", coordinating the links with each of the other devices (the "slaved" units).

e) The mobile terminal may look for the different services offered by the access point (or by the complete system served through the access point).

f) The mobile terminal may initiate, internally, a specific communication protocol stack and utilize one of the services advertised by the access point. The actual service will usually be provided by an entity different from the access point - such as a local server.

2.2.2 The identity module of the Bluetooth™ technology

The identity module of the Bluetooth™ technology is intrinsic within the Baseband module. In this technology, the identity consists of a 48 bit, globally unique address and the phase of an internal, free running clock. Both entities further determine the frequency-hopping pattern of the device. The frequency-hopping pattern of the device is important in cases where this device acts as the "master" in a Bluetooth™ piconet and determines the frequency-hopping pattern of all "slaved" devices.

2.2.3 Detachment and re-assignment of the identity module from the access points

Several methods may be employed for detaching and re-assigning the identity module from the access point.

(a) One technique involves re-programming of the identity module. By allowing re-programming of the identity module, the module itself, although physically part of the access point, is logically detached from a permanent affiliation with a fixed identity. The possibility of re-programming must involve all aspects of the identity module – the 48-bit address and the phase of the internal clock. The re-programming procedure must be allowed in real time. One advantage of this technique is the ability to implement it in a LAP or NAP types of access points. One disadvantage of this technique is that it must rely on special purpose Baseband modules (special purpose, in this case, pertains to the fact that a re-programmable Baseband module is not defined as part of the Bluetooth™ specifications).

(b) Another technique for detaching and re-assigning the identity module from the access point relies on physical detachment of the Baseband module from the access point. The Baseband modules that are detached from access points may be concentrated in one central location (e.g. the center station). A transport channel connects the central location and the suspended access points. In this case, the Baseband module operates normally, and does not re-program its own identity. The re-assignment may be based on a switching matrix that dynamically associates and re-associates the Baseband modules with different access points. The switching matrix may include K number of Baseband modules at one side (for clarity, will be referred to as inputs) and M number of transport channels on the other side (will be referred to as outputs) linking M number of suspended remote access points. This sub system of cellular communication system is described in figure 5.

The switch matrix may be implemented in different manners.

For example, the switch matrix may be a RF switch matrix. In this case, both radio and Baseband VLSI chips are located in the central location – at the input to the

switch matrix. The outputs are a group of RF transport channels. The suspended access points have minimal contents and include the antenna and possibly some additional RF components (e.g. RF filter, LNA). The transport channels are RF channels, for example, coaxial cables or optical fibers transporting the RF signals. This implementation is shown in figure 6.

One advantage of this configuration is its applicability to a combined system. A combined system implements more than one wireless technology within the same system. For example, a combined system may include Wireless LAN (IEEE 802.11) and Bluetooth™. The RF switch configuration can route either (or both) of the RF signals types to an access point. This system adapts itself to the mobile terminal which happens to be around – whether of the Wireless LAN or Bluetooth™ type.

One drawback of this configuration is the need to handle RF signals. For the case of Bluetooth™ the RF signal is about 2.4 GHz and is technically difficult to process. One variation of the RF configuration is based on down-conversion of the RF signal to a lower frequency, say, 100 MHz. The converted signal is processed (through the switch and possibly through the transport network) and then up-converted back to 2.4 GHz. This mechanism circumvents the need to handle high frequency signals.

Another example for the switch matrix is a digital switch matrix. In this case, the RF modules may reside on the suspended access point. The inputs to the switch matrix are the signals from the Baseband modules. These signals may be multiplexed one way or another and feeding one switch matrix. Alternatively, the signals from the Baseband module may feed several switch matrices (e.g. one matrix for the transmitted data, one matrix for RSSI signals etc). The transport channel in this case is digital, possibly multiplexing all signals from the Baseband module into one channel. This type of implementation is presented in figure 7.

This section described two possible implementations for detaching the permanent affiliation of an identity from a Bluetooth™ access point and the dynamic reassignment of the identity to various access points. The invention does not depend on any particular method and may be implemented in diversified ways. Furthermore, other types of cellular systems are constructed differently hence their implementation of the detachment and reassignment will differ. In all cases a control unit will implement the required algorithm and control the reassignment procedure.

2.2.4 Reassignment algorithm

The reassignment algorithm controls the dynamic reassignment between identities and access points. The control may take the form of re-programming the baseband module (as described in section 2.2.3 (a) above) or programming the switch matrix (as described in section 2.2.3 (b) above) or other control forms as appropriate with the detachment method chosen for the specific system.

The algorithm for controlling the reassignment between identities and access points depends on the services, which are provided by the cellular system. Three representative services and their derived algorithm are described below. All

algorithms are described for the implementation case described in 2.2.3 (b), specifically the one with the digital transport channel.

(a) Handover algorithm

The following description assumes a single mobile terminal linked to one access point (access point 2 in figure 8), which in turn is switched to operate with a Baseband module (BB chip A).

Initially, the mobile terminal is linked to access point (2) and communicates data and / or voice through that access point. This access point will be termed the active access point. During this time, the signal strength is monitored on the active access point and on the access points surrounding active access point (access points 1 and 3). The monitoring is enabled utilizing the RSSI signal from the radio module.

While RSSI is constantly being monitored on active access point, the algorithm for monitoring the surrounding access points may vary.

For example, cellular system may provide dedicated access points for monitoring around each active access point. These access points may be tuned to the same frequency-hopping pattern as the active access point. The tuning is achieved by allowing the switch matrix to connect Baseband module not only with active access point but also with the surrounding access points. For the case of monitoring, the switching matrix may perform partial signal switching. Specifically, the transmitted data and received data need only be switched to active access point. The control and RSSI signals need to be switched to both the active access point and the surrounding access points. Alternatively, the transmitted and received data may also be switched to the surrounding access point and summed at the Baseband module.

As another example, standard access points may serve for both, monitoring and normal active operation. In that case, the switch matrix will constantly connect Baseband module to the active access point and will connect Baseband module to the surrounding access points one by one, monitoring the RSSI of each access point. Alternatively, the switch matrix can connect more than one access point for monitoring and data transfer at the same time and measure the combined result.

Whatever algorithm is utilized, the RSSI signals provide indications related to the mobility of the mobile terminal. Specifically the RSSI signals indicate whether mobile terminal moves away from active access point (access point 2 in figure 8) and towards which access point this movement is (towards access point 3 in figure 8). Additional indications may be gathered from bit error control and statistically, from previous movement patterns of mobile terminals under access point.

At some point in time, indications show that the link between mobile terminal and active access point (access point 2) has become weak and a better active link will be provided by another access point (access point 3). At this time, the switch matrix will connect Baseband module (BB chip A) with the new access point (access point 3) and will, in general, disconnect access point (2) from the Baseband module (BB chipA).

The substitution of active access point with a new active access point goes completely unnoticed by mobile terminal. This new situation is shown in figure 9.

Depending on the configuration of the cellular system, Baseband module (BB chip A) may be connected by the switch matrix to both active access points (access points 2 and 3) for some period of time. Alternatively, access point (2) may be disconnected immediately upon the new connection of Baseband module (BB chip A) to access point (3).

Once access point (3) becomes the sole active link for mobile station than RSSI is continuously being monitored on active access point (3). Monitoring of the newly surrounding access points (2 and 4 in figure 9) is executed according to the relevant algorithm.

The algorithm described in this section is repeated as long as mobile terminal requires services from the cellular system.

(b) Dynamic resource allocation

As described in section 1.4.2, temporary clustering may cause local congestion on a specific access point. Rather than adding redundant access points and identity modules in all areas suspicious of being congested, a small pool of identity modules is reserved for congested areas.

An algorithm may be implemented in the cellular system, whereby clustering is recognized and the switching matrix is re-programmed to steer available identity modules towards access points within the congested area.

The algorithms for identifying congested areas may vary. As an example, when the local access point is overloaded by, say, links to five mobile terminals, the access points signals the switch matrix control unit to set up another "live" access point in the same area. The Bluetooth™ technology indeed allows several piconets to coexist in the same area.

(c) Distributed access points

The distributed access point algorithm allows one identity module to be distributed over two or more access points. This function may be required in cases where mobile terminals are sparsely populated in a site. Under this scenario, it can be assumed that each access point links to no more than one mobile terminal. Assuming that the mobile terminal does not require the full aggregate bandwidth offered by an access point, than the same identity module can serve another mobile terminal – at a different location. Essentially, this technique re-uses the bandwidth spatially.

The distributed access point technique may also be used for "splitting" an access point. For example, an access point may serve two mobile terminals. One mobile terminal begins to move around. The access point may now be split to support both the fixed location terminal and the moving terminal.

There is no specific algorithm that needs to be defined for a system supporting distributed access points.

2.3 Making use of the invention

A typical scenario will describe the use of the invention in a site served by a Bluetooth™ network. Access points are scattered within the site. The access points are connected to a central station, which consists of a switch matrix, control unit and all the required protocol processors.

2.3.1 Roaming scenario

In this typical scenario, each suspended unit on the ceiling of the site will include two access points, one for fixed location services and one for mobile services.

A mobile terminal entering the site would inquire about the available services in this site. Two access points will respond to the inquiry and will advertise their services. The "standard" access point will advertise low cost fixed location services with guaranteed bandwidth of 100 kbps. The other access point will advertise a high priced service allowing full and uninterrupted mobility within the site. Optionally, a third access point might provide service of a completely different technology.

A user, choosing to pay for the high priced service, will now own a piconet, which will track his location. Essentially, he is paying for a roaming piconet. Furthermore, the user is not required to own any specific mobile terminal, nor is he required to download any software utility or program his terminal. The handover process is initiated, controlled and executed by the infrastructure portion of the system and the mobile terminal may be of the "dumb" type and completely oblivious to the underlying process.

2.3.2 Self learning scenario

Another typical scenario is one where the user community (made of users holding some type of Bluetooth™ handheld mobile terminal) of the Bluetooth™ network moves about the site in an unpredictable manner. This movement creates "hot spots" of dense communication needs and other areas ("cold spots") where the communication needs are low. The "hot" and "cold" spots vary in time and in location.

The proposed system will implement redundant, low priced, access points within the site and an aggregate of identity modules sufficient for the aggregate communication requirements.

The cellular system adapts itself to the user community by applying three processes. One process releases identity modules by detaching them from access points located in "cold spots". The second process activates the distributed access point process – distributing specific identity modules among access points in the "cold spots". The

third process consists of assigning and re-assigning the released identity modules to access points within the "hot spot" area.

3. Claims

3.1 Flexibility in cellular communication systems

A technique for adding flexibility feature in cellular communication systems is claimed. The technique enables the system to adapt to variations in mobile user environment. The added flexibility allows the system to dynamically reorganize itself according to the local setting of users and temporary circumstances.

The technique is based on a fundamental change in the functionality of different components comprising a cellular communication system. Identities are logically detached from their permanent affiliation with the access point component. During operation of the cellular system, the identities are assigned and reassigned to different access points, in response to changing user conditions.

3.2 Innovative handover procedure

Referring back to the claim stated in section 3.1, an innovative method for handling handover procedure between access points in the flexible cellular communication system.

The handover procedure is initiated, controlled and executed by the infrastructure segment of the cellular system. The handover procedure is completely seamless from the mobile terminal perspective and does not require its cooperation.

The method involves two facets. One facet deals with measuring signal strength from the mobile terminal. The signal strength is monitored on the active access point and on access points surrounding the active access point. When the signal strength monitored on the active access point becomes too weak and one of the surrounding access points indicates a possible better link, the handover process is initiated. The second facet of the handover process is substituting the role of the active access point. The substitution takes place by reassigning the identity of the current active access point to the newly nominated active access point. The access point with the better link to the mobile terminal becomes the new active access point. The most recent active access point may or may not be part of the surrounding access points handling signal strength monitoring.

With respect to the role change moment, three modes of operation are defined. In one mode, the most recent active access point is disconnected immediately before the nomination of the new active access point. In a second mode of operation, the most recent active access point is disconnected immediately after the nomination of the new active access point. In a third mode of operation, two -or more- access points may be active at the same time.

3.3 Dynamic allocation of resources

Referring back to the claim stated in section 3.1, a method for dynamically allocating bandwidth at preferred locations.

Dynamic allocation of bandwidth resources is achieved by selective assigning of identity modules to specific access points. Specifically, an active access point identifies requests for connection – more than it can handle. That access point indicates the situation to a control unit which re-assigns additional identity modules to non-active access points in that same area.

3.4 Distributed cells

Referring back to the claim stated in section 3.1, a method for distributing one cell among different locations is claimed.

Cell distribution is achieved by assigning an identity module to more than one access point. This situation may occur when the user community of the cellular system is temporarily distributed unevenly across the site. Several identity modules are re-assigned to the areas exhibiting large user population, whereas other locations are "thinned out" by distributing identity modules in areas exhibiting low communication activities.

3.5 Multi technology combined system

A method for implementing a cellular communication system, combining more than one radio technology. The portion of the system, which resides on the access point, must be common to the technologies of interest. For example, the access point may consist of an antenna centered at 2.45 GHz. In this case, the combined system may include all technologies operating around 2.45 GHz and conforming to the general structure as defined in this invention. In this case, the identity module includes the remainder portions of the system, which are routed by the switch. This cellular system may respond to changing user environment. For example, the cellular system may serve, at a specific time, a user equipped with a notebook implementing wireless LAN. At a later time, the system may support a Cellphone equipped with a Bluetooth radio.

3.6 Re-assigning identities

Referring back to the claim stated in section 3.1, two detailed techniques for reassigning identities of access points - allowing operations such as nomination of a new active access point.

[The first technique involves re-programming of the identity module within each access point. The re-programming embraces all aspects of identity (e.g. frequency-hopping sequence and individual address). This means that mobile terminals cannot discern between access points, which were re-programmed to the same identity.]

The second technique involves a switch matrix. The term switch matrix may designate one (MxN) switch matrix designed to switch a multiplexed signal or a set of (MxN) switches, each one designed to switch one specific signal.

In this case, the identity modules are physically detached from the access points. The inputs to the switch matrix are essentially the array of identity modules. The outputs of the switch matrix are essentially the group of remote access points. Other modules, which are normally part of the access point, may now be located in the vicinity of the switch matrix (either in the input interface or at the output interface) or at the remote access point.

The switch matrix may be of the digital type or of the RF type – depending on the type of system and transport channel deployed. For the case of an RF based switched matrix, the RF signal may be down-converted to a lower frequency, handled by the matrix and than up-converted to the original frequency. Optionally, the down-converted signal may be up-converted at the access point.

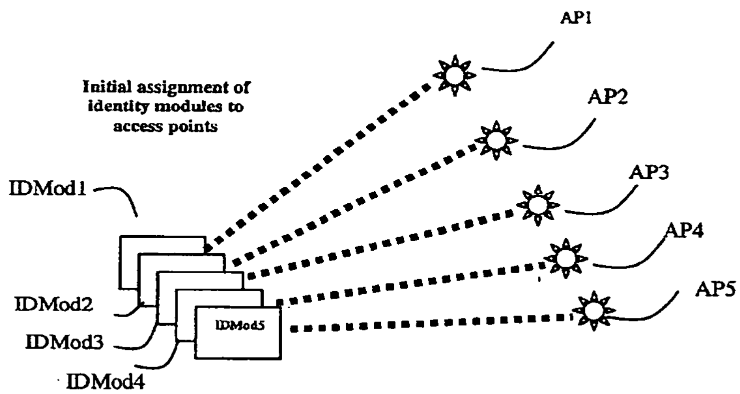
The switch matrix can dynamically assign and reassign each identity module to each access point.

An identity module may be assigned to more than one access point at the same. This feature may be utilized to distribute the same cell between several areas.

The switching matrix may assign partial signals from the identity module to the access point. Specifically, the switching matrix may assign the control signals (including the signal strength line) but not handle the data lines. This type of switch matrix is especially important in the case of access points designated for monitoring.

Abstract of the disclosure

The present invention deals with methods for adding new flexibility features to cellular communication systems. These flexibility features are obtained by detaching the identities of access points from their fixed affiliation and then reassigning the identity modules to access points on a per needed basis. Whereas the initial assignment of identity modules to access points may be as presented in the figure: identity module 1 (IDMod1) is assigned to Access Point 1 (AP1), identity module 2 (IDMod2) is assigned to Access Point 2 (AP2) and so on; A new assignment may affiliate identity module 1 (Idmod1) to some other access point or, possibly to several access points.



By reassigning identity modules to access points in a flexible manner, the cellular system optimally adapts itself to the user environment. For example, an access point may roam along with the mobile user – keeping a constant link to his terminal. The decision or algorithm for reassigning identity modules in this case may involve monitoring of signal strengths from several neighboring access points.

Several techniques may be implemented for realizing the dynamic assignment of identity modules to different access points. One technique involves a switch matrix with the array of identity modules as inputs and the array of access points as outputs. The switch matrix is controlled by a control unit, which implements the required algorithm.

Fig 1

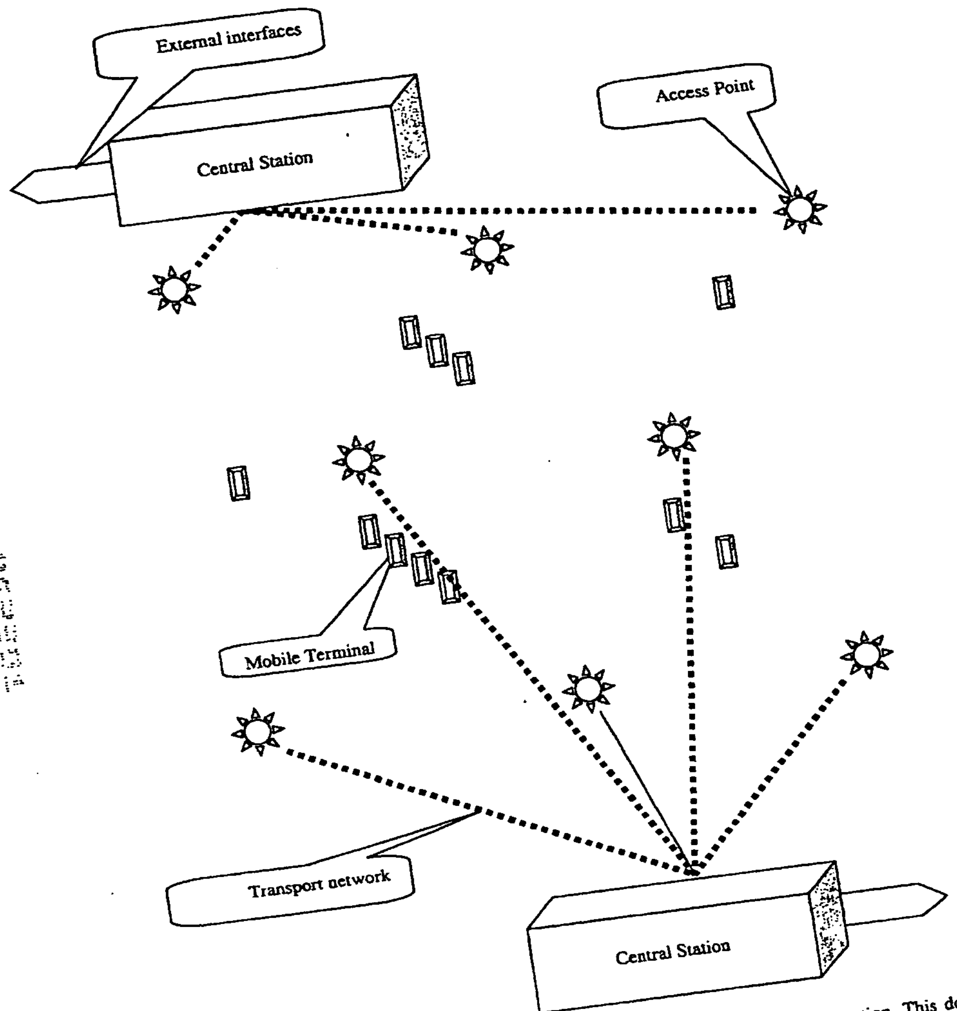
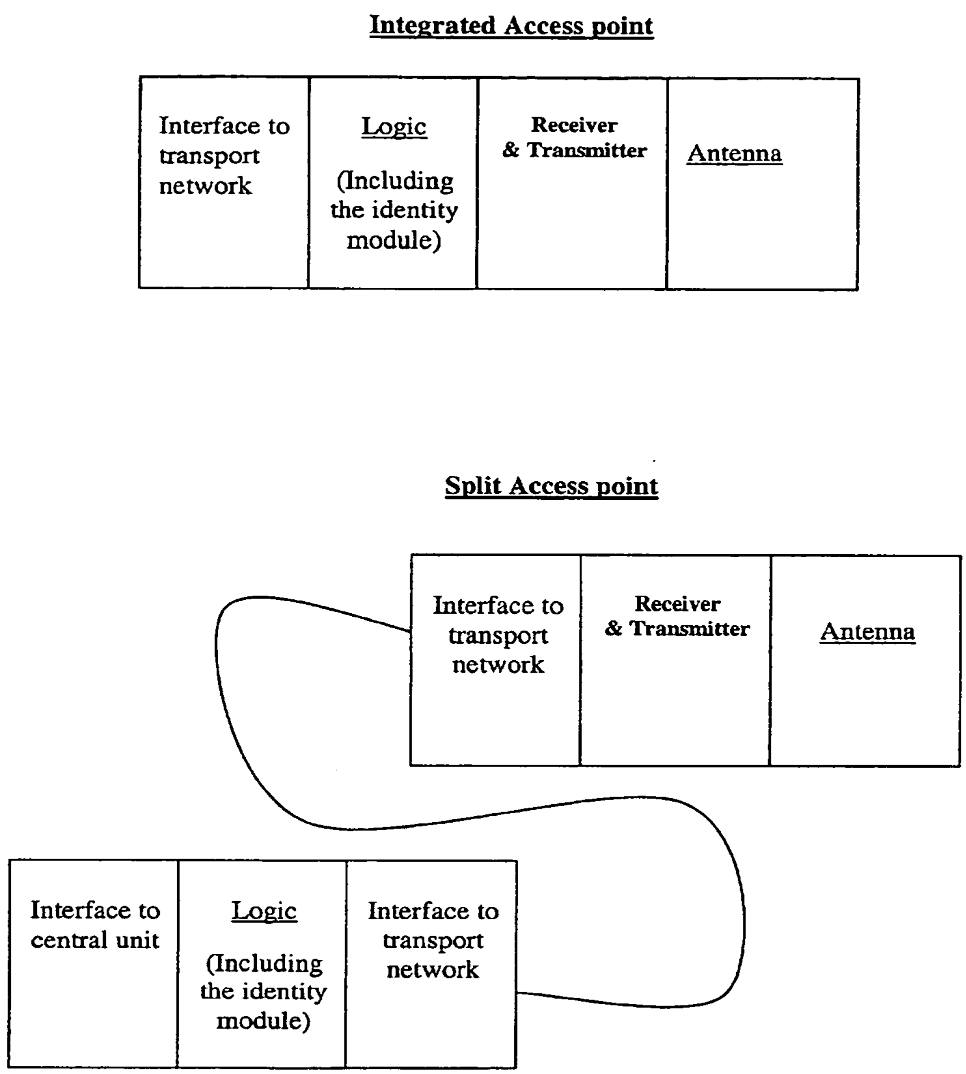
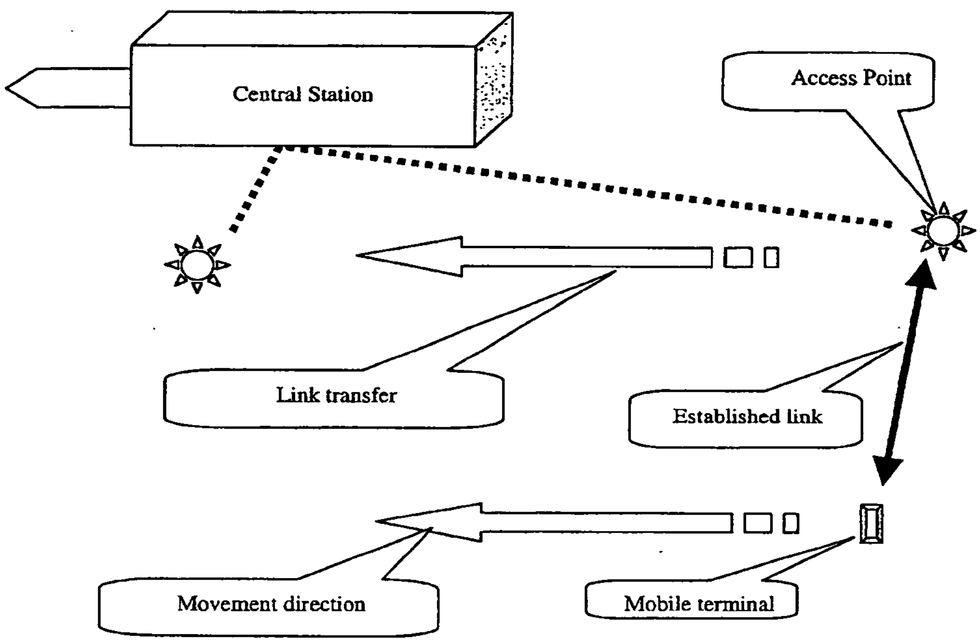

External interfaces
Access Point
Central Station
Mobile Terminal
Transport network
Central Station

Fig 2



Integrated Access point
Interface to transport network
Logic
(Including the identity module)
Receiver & Transmitter
Antenna
Split Access point
Interface to transport network
Receiver & Transmitter
Antenna
Interface to central unit
Logic
(Including the identity module)
Interface to transport network

Fig 3



Central Station
Access Point
Link transfer
Established link
Movement direction
Mobile terminal

Fig 4

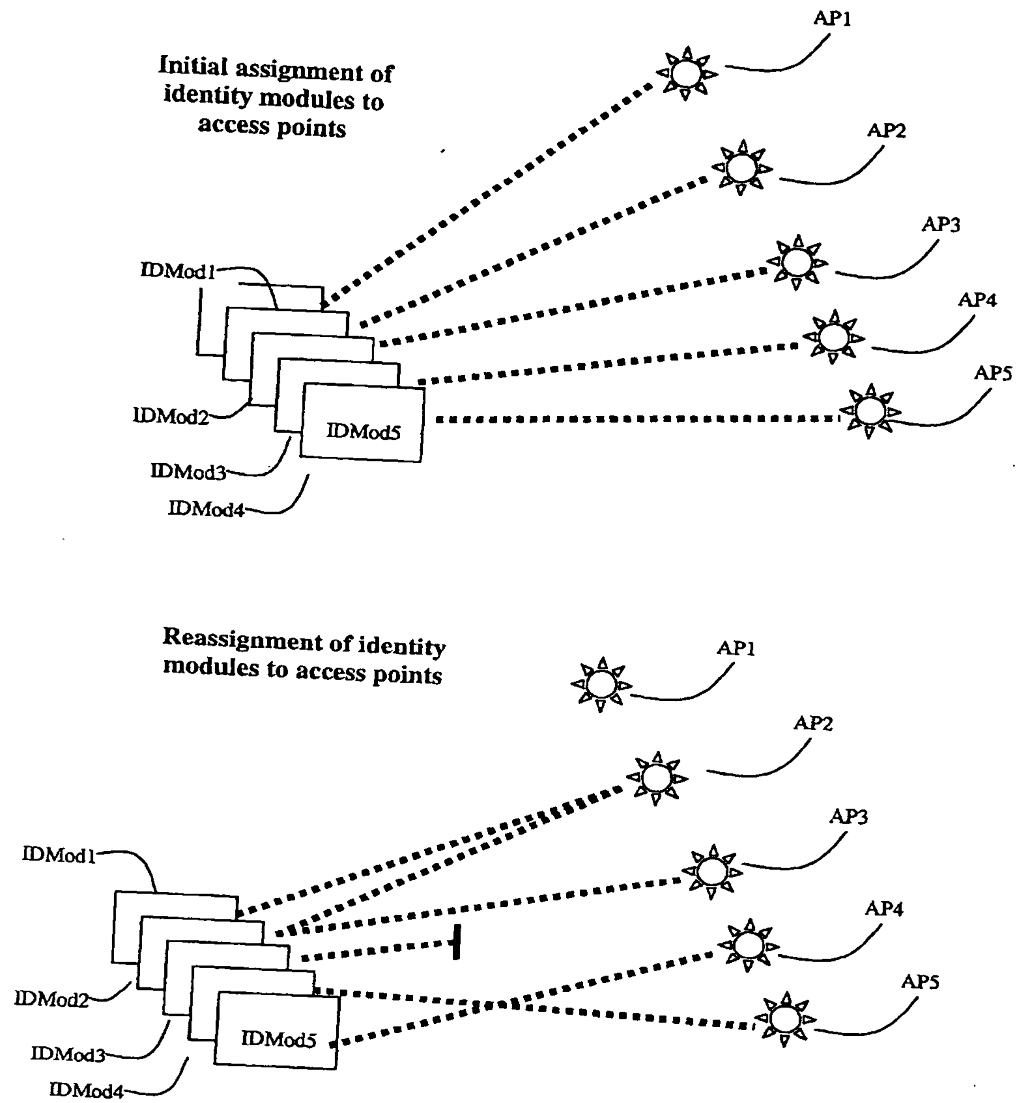

Initial assignment of identity modules to access points
AP1
AP2
AP3
AP4
AP5
IDMod1
IDMod2
IDMod3
IDMod4
IDMod5
Reassignment of identity modules to access points
AP1
AP2
AP3
AP4
AP5
IDMod1
IDMod2
IDMod3
IDMod4
IDMod5

Fig 5

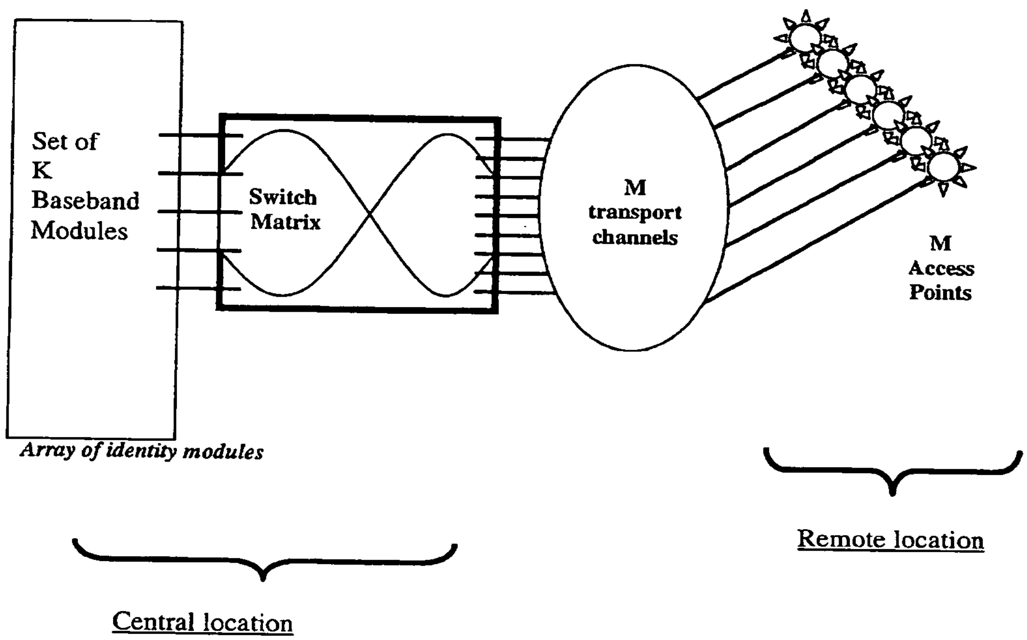
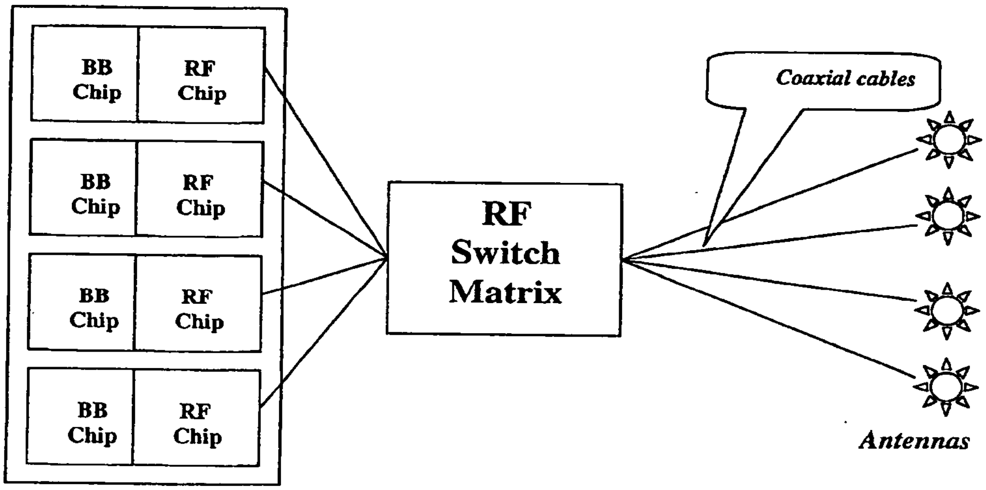

Set of
K
Baseband
Modules
Switch
Matrix
M
transport
channels
M
Access
Points
Array of identity modules
Remote location
Central location

Fig 6



Array of identity modules

Fig 7

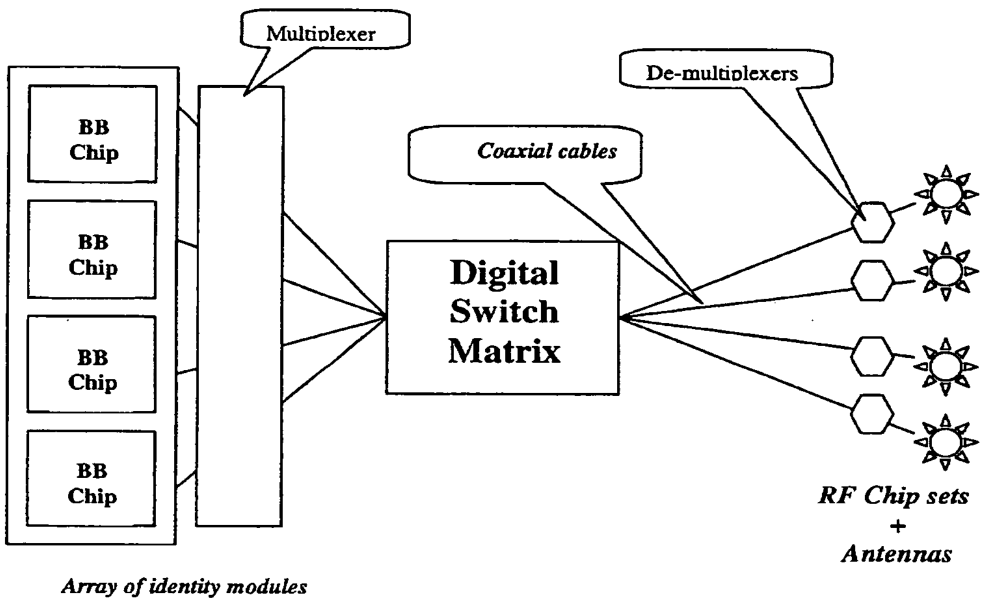

Multiplexer
De-multiplexers
Coaxial cables
BB Chip
BB Chip
BB Chip
BB Chip
Digital Switch Matrix
RF Chip sets + Antennas
Array of identity modules

Fig 8

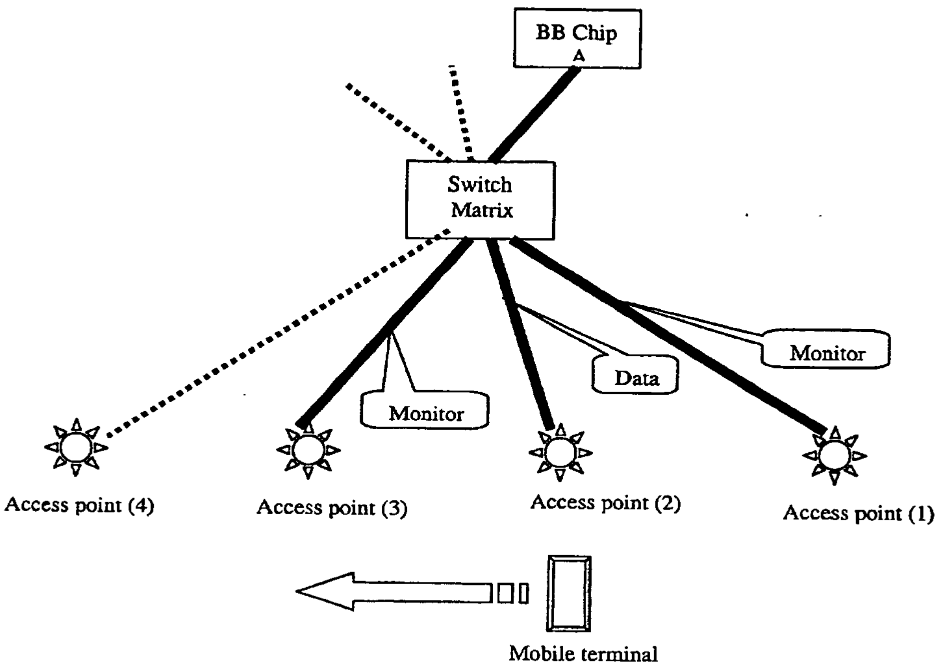
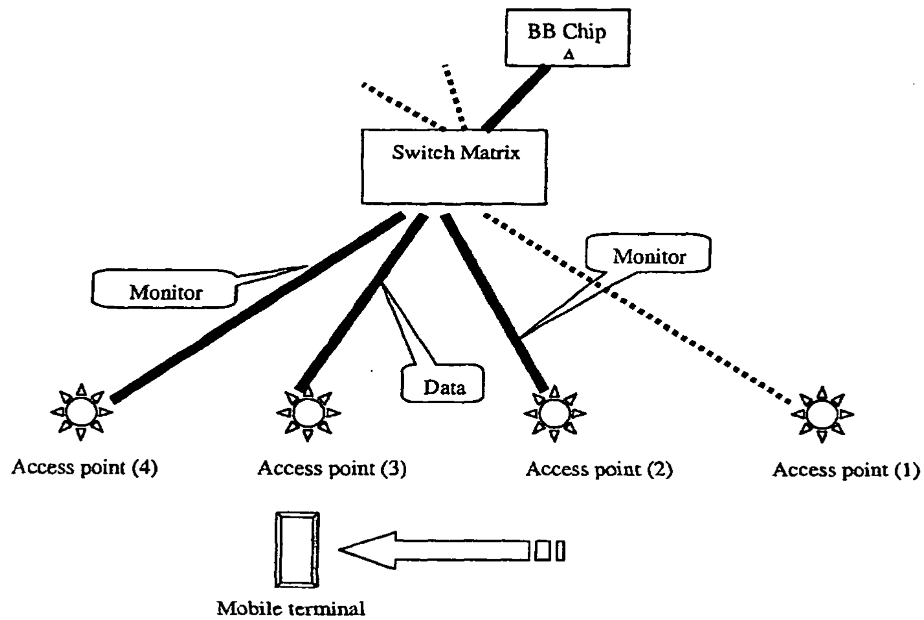

BB Chip
A
Switch
Matrix
Monitor
Data
Monitor
Access point (4)
Access point (3)
Access point (2)
Access point (1)
Mobile terminal

Fig 9



BB Chip
A
Switch Matrix
Monitor
Monitor
Data
Access point (4)
Access point (3)
Access point (2)
Access point (1)
Mobile terminal